Astrophysics Research And Analysis

An Experimental Program to Achieve High Accuracy Atomic Rates for the X-ray Astrophysics Recovery Mission and Beyond

Completed Technology Project (2018 - 2020)

Project Introduction

We propose an experimental program to generate high accuracy atomic data for the Fe XXV and Fe XXVI emission diagnostics. Theoretical calculations of specific rate coefficients have estimated accuracies ranging from 5 to 30%. The individual uncertainties may translate into uncertainties on the measurement of interest, e.g. electron temperature, of 30%. EBIT measurements will test the existing theoretical calculations, both the line emission and the individual atomic rates for various processes, including excitation, recombination and ionization. We also measure the spectra of H- and He-like Ar for comparison to theory. For Ar the resonance line series will provide another benchmark for the atomic physics data. We will conduct the experiments at electron beam ion traps (EBITs) at NIST and Clemson University. We will explore in detail broad ranges in parameter space for which the accuracy of the atomic data might be low, e.g. near the threshold where resonances contribute to the collision strength. The EBIT measurements will help set priorities for future theoretical calculations. Our program will use the NIST EBIT combined with a pair of crystal spectrometers to (a) measure diagnostic line ratios over a range in parameter space; (b) conduct detailed experiments to assess the accuracy of rates for individual atomic processes; and, (c) evaluate the existing theory and determine its accuracy for input to AtomDB. We will use the EBIT at Clemson to extract and recombining ions to test recombination rates. We expect to make relatively rapid progress by regularly communicating the results from our experiments and assessments to the atomic physics and astrophysics communities. Cosmology using clusters of galaxies relies on a highly accurate measurement of the electron temperature. With current CCD spectra, the shape of the high energy continuum, dominanted by bremsstrahlung, provides the best temperature determination. The microcalorimeter on the X-ray Astrophysics Recovery Mission, as demonstrated by Hitomi, will easily determine the ratio of the fluxes of the strong allowed transitions of Fe XXV and Fe XXVI, as well as for the temperature-sensitive line ratio of the He-like Fe XXV for high signal-to-noise cluster data. Improvements to the accuracy of these diagnostics will significantly reduce the systematics from cluster cosmology. These data will also be of broad use for other sources as well. Our team will make improved atomic data available to the astronomy community in a timely manner through AtomDB.

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Organization:

Smithsonian Institution

Responsible Program:

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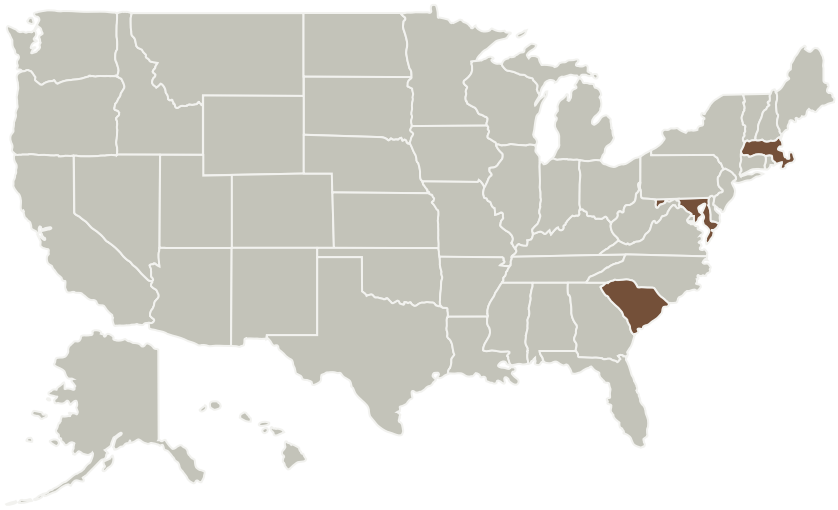
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Smithsonian Institution	Lead Organization	Industry	Washington, District of Columbia
Clemson University	Supporting Organization	Academia	Clemson, South Carolina
Curtin University of Technology	Supporting Organization	Academia	
Harvard-Smithsonian Center for Astrophysics	Supporting Organization	Industry	Cambridge, Massachusetts
National Institute of Standards and Technology(NIST)	Supporting Organization	US Government	Boulder, Colorado
Smithsonian Astrophysical Observatory(SAO)	Supporting Organization	US Government	Cambridge, Massachusetts

Project Management

Program Director:

Michael A Garcia

Program Manager:

Dominic J Benford

Principal Investigator:

Nancy S Brickhouse

Co-Investigators:

Jill Robidoux
Randall K Smith
Yuri Ralchenko
Adam Foster
Casey T Deroo
Endre Takacs
Eric H Silver
Ryan Allured
Igor Bray

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.1 Detectors and Focal Planes

Target Destination

Outside the Solar System

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Primary U.S. Work Locations	
Maryland	Massachusetts
South Carolina	